

Evaluation of wheat varieties (*Triticum aestivum* L.) grown under different seeding rates and ethephon in desert conditions, south of Basrah, Iraq

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Due to climate change in recent years, there has been an increasing water deficit during the winter wheat growing period due to reduce rivers water and low precipitation. Consequently, there is increasing thoughts to grow crops depending on well water under desert conditions were crops management completely different. Field experiment was conducted in winter session of 2021-2022. The aim was to evaluate the production of wheat cultivars grown under desert condition at Alahais south of Basrah, Iraq (30°46'89.07"N 46°99'36.77"E). Moreover, two seeding rate and two levels of ethephon have been applied. The experiment include three factors, eleven wheat cultivars, two rate of seeding (140 and 200 kg ha⁻¹) and two concentration of ethephon (0 and 2.25 ml l⁻¹). Factorial experiment was applied (11x2x2) according to randomized complete block design with three replicates. The area of experimental unit was 4x3 m². The results revealed that, wheat varieties differed significantly in all most traits measured. Alrasheed variety produced higher grain yield, higher grains spike⁻¹ and 1000 grain weight by 4.077 t ha⁻¹, 56.18 grains spikes⁻¹, and 43.17 g respectively. Moreover, increased seeding rate from 100 to 200 kg ha⁻¹ lead to increase spike m⁻² and grain yield by 12.53% and 11.59% respectively. In addition foliar application of ethephon lead to enhance spike m⁻², grains spike⁻¹ and grain yield by 5.31%, 6.81% and 11.15% respectively. For the interaction effect, the results revealed that, the increased of seeding rate improved grain yield for all wheat varieties. Moreover, the application of ethephon improved grain yield for all wheat varieties. Alrasheed variety under 140 and 200 kg ha⁻¹ seeding rate with foliar application of 2.25 ml l⁻¹ ethephon gave highest grain yield by 4.321 and 4.235 t ha⁻¹ respectively. In addition Alrasheed under seeding rate of 200 kg ha⁻¹ and ethephon foliar application produced highest biological yield by 14.261 t ha⁻¹. The results showed that foliar application of ethephon compensate the increase of seeding rate from 140 to 200 kg ha⁻¹ for grain yield of some wheat varieties.

Keyword: Wheat varieties, desert agriculture, ethephon, grain yield, seeding rate.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the major cereal crops, which provides energy requirement of the human diet across the world. Wheat grain's protein contains essential gluten, which is important for bread production (Sharma *et al.*, 2015; Noaema *et al.*, 2020; Alrishdi and Alhabbar, 2023). The total wheat production in the world estimated by 779.03 million tons, at a rate of 3.510 t ha⁻¹ (USDA, 2022). While, in Basrah Governorate which located south of Iraq, Wheat production reached to 2.624 t ha⁻¹ (ARMA, 2021). In addition to the decline in grain yield production per unit area in Iraq as compared to global production, climatic changes have played a major role in reduced agricultural production due to the increase water scarcity and the decrease water level of Tigris

and Euphrates rivers, which consequently led to decrease cultivated area with field crops, including wheat (Lobell *et al.*, 2011; Osborne and Wheeler, 2013; Kissoudis *et al.*, 2016; Urban *et al.*, 2017). This required searching for alternative sources of water (underground water) and moving the cultivation of this strategic crop to other new regions. This new region characterized by abundance of underground water but in other hand by extremes climate, insufficient nutrient and light soils that differ in their characteristics and so their management as compared to suitable soils for Wheat cultivation. This requires reconsideration by selecting a new varieties that are suitable for these new agricultural conditions. Varieties generally differ in grain yield production according to genetic traits and its interaction with Ecology (growth conditions). The highest yield can be obtained when

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there is a compatibility between the genotypes and available growth conditions (when these conditions are invested in a manner optimize) (Inamullah *et al.*, 2011; Altaweel and Alhamdani, 2022). Determine appropriate seed rate that achieve the suitable plant density to invest in growth and production factors with high efficiency by reducing competition among plants on soil resources and increase light distribution and heat available and thus regulate physiological processes in plants which reflect positively on growth, yield and its components (Turner *et al.*, 1994). The use of growth regulators is considered one of the new technologies that represent in agricultural production. Growth inhibition group is among the growth regulators that have described as slowing down elongation and cell division in the sub-apical meristem, which reduces stem elongation. Studies have indicated that the effect of these compounds in increasing grain yield is not by inhibiting stem elongation but by its positive effect on the yield components (Al-Zubaidi and Mohsen, 2022). Ethephon is among the growth regulators commonly used with grain crops, especially wheat. Some research has indicated its ability and effectiveness in preventing apical stigmas, increasing number of tillers, and then increasing the number of spikes per plant, which is one of the important components of grain yield (Kolbert *et al.*, 2019; Hussain *et al.*, 2020). Therefore, this study aimed to evaluate performance of introduced genotypes for light soils, seeding rate and ethephon application and their interaction which will give the highest grain yield and quality under desert conditions south of Iraq.

MATERIALS AND METHODS

A Field experiment was conducted in winter session of 2021-2022 at Al-Luhais south of Basrah, Iraq (30°46'89.07"N 46°99'36.77"E). The objectives were to evaluate the some growth properties, grain yield and component of eleven wheat genotype *Triticum aestivum* L. (Abugraib3, Alrasheed, Barcelona, Mawada, Jehan, Wafyah, IPA99, Babyl, Bhooth22, Jihad and Adina) to grow in desert condition under the effect of tow seeding rate (140 and 200 kg ha⁻¹) which they are symbolized by S₁ and S₂ and two ethephon concentration (0 and 2.25 ml l⁻¹) which they are symbolized by A₀ and A₁. Factorial experiment was applied (11x2x2) according to randomized complete block design with three replicates. The total number of experimental units was 132 with a distance aria of 4x3 m². Experimental soil was prepared by two orthogonal tillage and then, soil leveled by disc harrows. Random samples were taken from a well of water and soil before planting (depth of 0-30cm), dried and passed in a 2 mm sieve to determine some physical and chemical properties of water and soil (Table 1 and 2). In addition, weather information obtained from Iraq ministry of agriculture (Table 3). Seeds were sowing at 21/11/2022 and NPK fertilizer (20:20:20) was added to the soil at seed sowing at 200 kg h⁻¹.

Watering system used was sprinkler irrigation method. Nitrogen fertilizer was added in form of urea, (46% N) at 200 kg h⁻¹ at two equal time, the first one at tillering stage and the second one at booting stage. Moreover, microelements Mg, Mn, Fe, Zn and Cu foliar applied at 400 g per 400 l⁻¹ ha⁻¹ at two equal time, elongation and booting stage. Ethephon treatments were sprayed at the beginning of tillering stage. Tween 20 was used to decrease the surface tension of solution. Samples harvested when plants reached to maturity stage (25/04/2022) and, yield, components and biological yield, harvest index and protein content measured from harvested plants of 1 m² from each experimental unit. Data were collected and analyzed statistically by GenStat statistical software 12 (Table 3). Averages of data were compared by using least significant difference (LSD P≤0.05).

Table 1. Some physical and chemical properties of well water.

| Properties | Value | unit |
|------------------|-------|--------------------|
| pH | 7.58 | - |
| EC | 4.20 | ds m ⁻¹ |
| Ca | 7.65 | mM l ⁻¹ |
| Mg | 4.12 | |
| Na | 2.99 | |
| HCO ₃ | 1.90 | |
| CL | 29.24 | |
| K | 1.87 | |
| SAR | 0.61 | - |

Table 2. Some physical and chemical properties of experimental soil before seeds sowing.

| Properties | Value at 20 cm | Value at 40 cm | unit |
|--------------------------------|----------------|----------------|----------------------------------|
| pH | 7.19 | 7.04 | - |
| EC | 5.20 | 6.00 | ds m ⁻¹ |
| N | 33.00 | 30.00 | mg kg ⁻¹ |
| P | 3.24 | 2.48 | |
| K | 234.50 | 368.20 | |
| CaCO ₃ | 254.30 | 265.70 | g kg ⁻¹ |
| O.M. | 6.50 | 6.70 | g kg ⁻¹ |
| sand | 792.00 | 812.00 | g kg ⁻¹ |
| silt | 80.00 | 80.00 | g kg ⁻¹ |
| clay | 128.00 | 108.00 | g kg ⁻¹ |
| Soil type | Loamy sand | | - |
| Water content at | 0.114 | 0.162 | cm ³ cm ⁻³ |
| Field capacity | | | |
| Water content at wilting point | 0.074 | 0.104 | cm ³ cm ⁻³ |

RESULTS

Spike m⁻²: The results of Table 5 showed significant differences between wheat cultivars, seeding rate and foliar



Table 3. Weather information of study locations. Information obtained from ministry of Agriculture.

| Month-Year | Week | Temp. Min. C° | Temp. Max C° | Average Temp. C° | Humidity Min. % | Humidity Max. % | Evaporation mm | Rainfall mm |
|------------|------|---------------|--------------|------------------|-----------------|-----------------|----------------|-------------|
| Nov-21 | 1 | 17.52 | 32.78 | 25.15 | 17.00 | 51.87 | 3.69 | 0.00 |
| | 2 | 12.20 | 27.15 | 19.67 | 17.27 | 55.02 | 3.43 | 0.00 |
| | 3 | 12.28 | 25.95 | 19.11 | 16.37 | 63.84 | 3.10 | 0.00 |
| | 4 | 11.71 | 26.12 | 18.92 | 19.84 | 68.81 | 2.77 | 0.00 |
| Dec-21 | 1 | 8.96 | 23.39 | 16.18 | 18.21 | 77.27 | 2.83 | 0.00 |
| | 2 | 7.61 | 22.59 | 15.10 | 21.55 | 77.34 | 2.90 | 0.01 |
| | 3 | 13.19 | 21.76 | 17.48 | 43.20 | 95.56 | 2.26 | 2.41 |
| | 4 | 6.76 | 16.42 | 11.59 | 37.58 | 84.78 | 2.19 | 0.51 |
| Jan-22 | 1 | 6.45 | 16.10 | 11.27 | 32.04 | 83.19 | 1.35 | 3.00 |
| | 2 | 10.08 | 20.41 | 15.24 | 24.84 | 77.12 | 1.54 | 0.15 |
| | 3 | 2.55 | 14.20 | 8.38 | 26.59 | 80.14 | 1.76 | 0.00 |
| | 4 | 6.13 | 18.96 | 12.55 | 23.89 | 80.02 | 2.23 | 2.54 |
| Fib-22 | 1 | 8.26 | 19.46 | 13.86 | 26.64 | 80.07 | 2.64 | 0.43 |
| | 2 | 8.47 | 21.93 | 15.20 | 20.35 | 77.74 | 3.04 | 0.01 |
| | 3 | 9.59 | 23.69 | 16.64 | 22.66 | 78.68 | 3.86 | 0.00 |
| | 4 | 11.38 | 25.27 | 18.32 | 27.65 | 83.68 | 3.84 | 1.03 |
| Mar-22 | 1 | 9.04 | 24.87 | 16.96 | 18.86 | 75.40 | 4.01 | 0.01 |
| | 2 | 14.89 | 26.07 | 20.48 | 13.67 | 61.92 | 3.97 | 0.00 |
| | 3 | 8.13 | 22.67 | 15.40 | 19.97 | 74.85 | 3.97 | 0.00 |
| | 4 | 10.56 | 27.63 | 19.09 | 17.04 | 63.43 | 4.49 | 0.00 |
| Apr-22 | 1 | 15.39 | 29.62 | 22.50 | 10.85 | 53.87 | 6.01 | 0.00 |
| | 2 | 17.53 | 32.19 | 24.86 | 12.41 | 53.11 | 6.61 | 0.00 |
| | 3 | 17.84 | 30.62 | 24.23 | 10.47 | 44.46 | 7.06 | 0.00 |
| | 4 | 14.17 | 29.96 | 22.06 | 12.41 | 51.31 | 6.84 | 0.00 |

Table 4. Analysis of variance represented by Mean of Square of yield and components of wheat varieties growing under different seeding rates and Ethephon at desert conditions.

| S.O.V | d.f. | Spike m ⁻² | Grains Spike ⁻¹ | 1000 grain weight | Grain yield t ha ⁻¹ | Biological yield t ha ⁻¹ | HI % | Protein % |
|-----------|------|-----------------------|----------------------------|-------------------|--------------------------------|-------------------------------------|----------|-----------|
| Replicate | 2 | 110.8 | 4.025 | 10.535 | 0.03220 | 0.0967 | 2.757 | 1.414 |
| V | 10 | 10983.4** | 577.230** | 294.941** | 3.59924** | 22.8432** | 21.349** | 5.498** |
| S | 1 | 295169.6** | 832.366** | 110.826** | 3.42936** | 43.0675** | 3.539 | 24.658** |
| E | 1 | 46536.0** | 149.739** | 0.099 | 10.69431** | 71.2164** | 26.718** | 9.531** |
| V.S | 10 | 3159.8** | 36.582** | 10.016 | 0.31158** | 1.7434** | 14.505** | 1.485 |
| V.E | 10 | 1665.4** | 60.859** | 34.082** | 0.20881** | 2.1585** | 4.272** | 0.617 |
| S.E | 1 | 23025.2** | 16.742* | 26.943 | 2.12535** | 11.0597** | 3.354 | 0.108 |
| V.S.E | 10 | 1735.4** | 8.843* | 3.107 | 0.26325** | 1.5557** | 1.639 | 0.576 |
| Error | 86 | 153.9 | 4.019 | 5.468 | 0.06505 | 0.3651 | 1.902 | 1.685 |

* Significant at $P \leq 0.05$; ** Significant at $P \leq 0.01$

application of ethephon in spike m⁻², Barcelona gave highest average by 491.36 spike m⁻², whereas, Wafyah gave the lowest average by 389.66 spike m⁻². The increase of seeding rate from 140 to 200 kg ha⁻¹ increased spike m⁻² by 12.53%. Foliar application of ethephon increased number of tillers by plants which reflect positively on spike m⁻². The results of table 6 indicated that there is significant interaction between wheat varieties and seeding rates. The increase of seeding rate significantly increased spike m⁻² for all wheat varieties. Barcelona variety under S₂ gave the highest average by 507.48 spike m⁻². While, Wafyah variety under S₁ gave the lowest average by 358.16 spike m⁻². The results of Table 7 showed that, the interaction of wheat varieties and ethephon have significant effect on spike m⁻². Foliar application of

ethephon significantly increased spike m⁻² for all wheat varieties. Barcelona variety under E₁ foliar application gave highest average by 486.42 spike m⁻². While, Wafyah variety under E₀ foliar application of ethephon gave the lowest average by 367.77 spike m⁻². The results of table 8 indicated that, there is significant interaction between seeding rate and foliar application of ethephon. Increased both seeding rate and foliar application of ethephon significantly increased spike m⁻². The interaction of S₂ x E₁ gave highest average by 490.5 spike m⁻², while the interaction of S₁ x E₀ gave lowest average by 358.4 spike m⁻². The results of Table 9 showed that, the interaction of wheat varieties, seeding rate and ethephon have significant effect on spike m⁻². Barcelona variety under S₂ and foliar application of ethephon (E₁) gave highest average by



519.52 spike m⁻². While, Wafya under S₁ seeding rate with no foliar application of ethephon (E₀) gave lowest average by 347.66 spike m⁻².

Grains Spike⁻¹: The results of Table 5 showed significant effect for wheat cultivars, seeding rate and foliar application of ethephon in grains spike⁻¹. Alrasheed variety gave highest average by 56.18 grains spike⁻¹. Whereas, Wafyah gave the lowest average by 29.63 grains spike⁻¹. The increase of seeding rate from 140 to 200 kg ha⁻¹ reduced kernels spikes⁻¹ by 12.68%. Foliar application of ethephon increased significantly grains spike⁻¹ by 7.27% as compared to control. The results of Table 6 indicated that there is significant interaction between wheat varieties and seeding rates. The increase of seeding from 140 to 200 kg ha⁻¹ significantly reduced grains spike⁻¹ for all wheat varieties. Alrasheed

variety under S₁ seeding rate gave the highest average by 61.12 grains spike⁻¹. While, Wafyah variety under S₂ seeding rate gave the lowest average by 25.14 grains spike⁻¹. The results of Table 7 showed that, the interaction of wheat varieties and ethephon have significant effect on grains spike⁻¹. Foliar application of ethephon increased kernels spikes⁻¹ for all wheat varieties except for Mawada and Wafyah. Alrasheed variety under E₀ and E₁ concentration of ethephon gave highest average by 56.88 and 55.48 grains spike⁻¹. While, Wafyah and Jehan variety under E₀ foliar application of ethephon gave the lowest average by 30.64 and 32.92 grains spike⁻¹ respectively. The results of table 8 indicated that, there is significant effect for the interaction between seeding rate and foliar application of ethephon on grains spike⁻¹. The interaction of S₁ x E₁ gave highest average by 41.16 grains

Table 5. Effect of Wheat varieties, seeding rate and ethephon on grain yield, components, harvest index, biological yield and protein content.

| Treatment | | Spikes m ⁻² | Grains Spikes ⁻¹ | 1000 grain weight (g) | Grain yield (t ha ⁻¹) | Biological yield (t ha ⁻¹) | Harvest index | Protein% |
|----------------------------------|--------------|------------------------|-----------------------------|-----------------------|-----------------------------------|--|---------------|----------|
| Varieties | Abugraib3 | 474.42 | 40.17 | 29.95 | 3.300 | 10.462 | 31.55 | 13.29 |
| | Alrasheed | 430.02 | 56.18 | 43.17 | 4.077 | 12.435 | 32.80 | 11.52 |
| | Barcelona | 491.36 | 36.18 | 30.14 | 3.388 | 11.500 | 29.48 | 12.34 |
| | Mawada | 474.57 | 32.27 | 41.12 | 3.663 | 12.192 | 30.02 | 11.89 |
| | Jehan | 445.58 | 39.23 | 36.61 | 3.675 | 11.430 | 32.20 | 10.89 |
| | Wafyah | 389.66 | 29.63 | 29.15 | 3.019 | 10.741 | 28.12 | 13.08 |
| | IPA-99 | 456.44 | 39.54 | 39.47 | 3.612 | 11.386 | 31.69 | 12.63 |
| | Babyl | 432.21 | 35.24 | 39.63 | 3.685 | 11.698 | 31.45 | 11.99 |
| | Bhooth22 | 457.26 | 34.17 | 38.97 | 3.193 | 10.233 | 31.18 | 12.05 |
| | Jihad | 456.32 | 34.34 | 39.14 | 3.457 | 10.884 | 31.80 | 12.08 |
| | Adina | 466.09 | 37.12 | 36.12 | 3.685 | 11.630 | 31.55 | 11.90 |
| | LSD (P≤0.05) | 10.07 | 1.63 | 1.90 | 0.207 | 0.490 | 1.12 | 1.05 |
| Seeding rate Kg ha ⁻¹ | 140 | 407.07 | 40.31 | 37.97 | 3.330 | 10.749 | 30.98 | 12.58 |
| | 200 | 458.09 | 35.20 | 36.14 | 3.716 | 11.904 | 31.26 | 11.72 |
| | LSD (P≤0.05) | 4.29 | 0.69 | 0.81 | 0.088 | 0.209 | N.S | 0.45 |
| Ethephon ml l ⁻¹ | 0 | 421.38 | 36.43 | 37.08 | 3.337 | 10.585 | 31.53 | 12.42 |
| | 2.25 | 443.78 | 38.91 | 37.03 | 3.709 | 12.068 | 30.74 | 11.88 |
| | LSD (P≤0.05) | 4.29 | 0.69 | N.S | 0.088 | 0.209 | 0.48 | 0.45 |

Table 6. Effect of the interaction of wheat varieties and seeding rate on grain yield, components, harvest index, biological yield and protein content.

| Varieties | Spikes m ⁻² | | Grains Spikes ⁻¹ | | 1000 grain weight (g) | | Grain yield (t ha ⁻¹) | | Biological yield (t ha ⁻¹) | | Harvest index | | Protein% | |
|--------------|------------------------|--------|-----------------------------|-------|-----------------------|-------|-----------------------------------|-------|--|--------|---------------|-------|----------|-------|
| | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 |
| Abugraib3 | 420.79 | 473.47 | 41.48 | 38.86 | 29.38 | 30.52 | 3.194 | 3.406 | 10.008 | 10.916 | 31.87 | 31.23 | 13.46 | 13.12 |
| Alrasheed | 382.25 | 442.73 | 61.12 | 51.24 | 39.82 | 39.45 | 3.990 | 4.164 | 11.202 | 13.669 | 35.63 | 30.43 | 12.64 | 10.40 |
| Barcelona | 445.82 | 507.48 | 39.68 | 33.82 | 30.80 | 29.47 | 3.409 | 3.368 | 11.042 | 11.958 | 30.89 | 28.18 | 12.89 | 11.79 |
| Mawada | 433.55 | 471.42 | 33.80 | 30.74 | 43.01 | 39.32 | 3.496 | 3.830 | 11.437 | 12.948 | 30.59 | 29.58 | 12.34 | 11.43 |
| Jehan | 388.92 | 460.06 | 40.84 | 37.62 | 38.29 | 34.92 | 3.537 | 3.814 | 11.040 | 11.820 | 32.07 | 32.23 | 10.89 | 10.90 |
| Wafyah | 358.16 | 395.82 | 34.12 | 25.14 | 28.93 | 29.36 | 2.495 | 3.543 | 10.398 | 11.085 | 24.04 | 31.95 | 13.14 | 13.02 |
| IPA-99 | 407.87 | 457.21 | 43.34 | 35.74 | 41.31 | 37.62 | 3.366 | 3.859 | 11.150 | 11.623 | 30.22 | 33.22 | 13.13 | 12.13 |
| Babyl | 387.36 | 429.46 | 38.90 | 31.58 | 44.07 | 42.26 | 3.593 | 3.777 | 11.297 | 12.098 | 31.77 | 31.24 | 12.34 | 11.64 |
| Bhooth22 | 406.90 | 456.17 | 36.70 | 31.64 | 39.17 | 38.77 | 2.917 | 3.470 | 09.565 | 10.901 | 30.54 | 31.83 | 12.35 | 11.76 |
| Jihad | 416.74 | 466.19 | 33.10 | 35.58 | 40.90 | 37.37 | 3.091 | 3.824 | 09.606 | 12.163 | 32.15 | 31.41 | 13.06 | 11.11 |
| Adina | 429.38 | 479.04 | 40.31 | 35.20 | 41.98 | 38.46 | 3.544 | 3.826 | 11.490 | 11.770 | 31.44 | 33.07 | 12.17 | 11.64 |
| LSD (P≤0.05) | 14.24 | | 2.301 | | NS | | 0.293 | | 0.694 | | 1.583 | | NS | |



spike⁻¹, while the interaction of S₂ x E₀ gave lowest average by 34.01 grains spike⁻¹. The results of Table 9 showed that, the interaction of wheat varieties, seeding rate and ethephon have significant effect on grains spike⁻¹. Babyl variety under S₁ and foliar application of ethephon (E₁) gave highest average by 44.91 grains spike⁻¹ with no significant differences from the interaction of (Mawada x S₁ x E₁), (Babylon x S₁ x E₀), (Jehan x S₁ x E₀) and (Mawada x S₁ x E₀) by 44.91, 43.54, 43.24, 43.13 and 42.29 grains spike⁻¹ respectively. While, Wafyah under S₁ seeding rate with no foliar application of ethephon (E₀) gave lowest average by 28.13 grains spikes⁻¹ with no significant differences from the interaction of (Abugraib3 x S₁ x E₀), (Barcelona x S₁ x E₀), (Barcelona x S₂ x E₀) and (Abugraib3 x S₂ x E₀) by 28.13, 28.29, 28.34, 29.16 and 29.62 grains spike⁻¹ respectively.

1000 grains weight (g): The results of Table 5 showed significant differences between wheat varieties and seeding rate in 1000 grains weight. Alrasheed variety gave highest average by 43.17 g. Whereas, Wafyah gave the lowest average by 29.15 g. The increase of seeding rate from 140 to 200 kg ha⁻¹ reduced 1000 grains weight by 4.82%. The results of Table 7 showed that, the interaction of wheat varieties and ethephon have significant effect on 1000 grains weight. Foliar application of ethephon increased 1000grains weight for all most wheat varieties except for Jehan, IPA-99 and Bhooth22. Babyl under E₁ and E₀ foliar application of ethephon gave highest average by 44.06 and 42.27 g. While, Barcelona, Abugraib3 and Wafya under E₀ ethephon and Wafya and

Abugraib3 under E₁ ethephon gave the lowest 1000 grains weight by 28.75, 28.95, 29.13, 29.16 and 30.95 g respectively.

Grain yield (t ha⁻¹): The results of Table 5 showed significant differences between wheat varieties, seeding rate and foliar application of ethephon on grain yield. Alrasheed variety gave highest average by 4.077 t ha⁻¹, whereas, Wafyah gave the lowest average by 3.019 t ha⁻¹. The increase of seeding rate from 140 to 200 kg ha⁻¹ increased grain yield by 11.59%. Foliar application of ethephon increased significantly grain yield by 11.15%. The results of table 6 indicated that there is significant interaction between wheat varieties and seeding rates. The increase of seeding rate lead to significantly increased grain yield for all wheat varieties except Barcelona and Babyl. Alrasheed variety under S₂ and S₁ seeding rate gave the highest average by 4.164 and 3.990 t ha⁻¹ respectively. While, Wafyah variety under S₁ seeding rate gave the lowest average by 2.495 t ha⁻¹. The results of Table 7 showed that, the interaction of varieties and ethephon have significant effect on grain yield. Foliar application of ethephon significantly increased grain yield for all wheat varieties. Alrasheed and Mawada variety under E₁ foliar application of ethephon gave highest average by 4.278 t ha⁻¹. While, Wafyah and Bhooth22 under E₀ gave the lowest average by 2.899 and 2.975 t ha⁻¹ respectively. The results of Table 8 showed significant effect for interaction of seeding rate and foliar application of ethephon on grain yield. Foliar application of ethephon lead to increase grain yield under both seeding rate S₁ and S₂. The interaction of S₂ x E₁ and S₁ x E₁

Table 7. Effect of the interaction of wheat varieties and ethephon on grain yield, components, harvest index, biological yield and protein content.

| Varieties | Spikes m ⁻² | | Grains Spikes ⁻¹ | | 1000 grain weight (g) | | Grain yield (t ha ⁻¹) | | Biological yield (t ha ⁻¹) | | Harvest index | | Protein% | |
|--------------|------------------------|--------|-----------------------------|-------|-----------------------|-------|-----------------------------------|-------|--|--------|---------------|-------|----------|-------|
| | E0 | E1 | E0 | E1 | E0 | E1 | E0 | E1 | E0 | E1 | E0 | E1 | E0 | E1 |
| Abugraib3 | 440.64 | 453.62 | 40.06 | 40.28 | 28.95 | 30.95 | 3.067 | 3.534 | 9.923 | 11.001 | 30.91 | 32.12 | 13.49 | 13.09 |
| Alrasheed | 407.42 | 417.56 | 55.48 | 56.88 | 38.57 | 40.70 | 3.876 | 4.278 | 11.754 | 13.116 | 32.98 | 32.62 | 11.28 | 11.75 |
| Barcelona | 466.88 | 486.42 | 35.90 | 37.60 | 28.75 | 31.52 | 3.184 | 3.593 | 10.599 | 12.401 | 30.04 | 28.97 | 12.74 | 11.94 |
| Mawada | 438.95 | 466.02 | 33.04 | 31.50 | 40.99 | 41.34 | 3.406 | 3.920 | 11.322 | 13.063 | 30.08 | 30.01 | 11.99 | 11.79 |
| Jehan | 414.04 | 434.94 | 35.38 | 43.08 | 40.95 | 32.26 | 3.429 | 3.922 | 10.885 | 11.976 | 31.50 | 32.75 | 11.35 | 10.44 |
| Wafya | 367.77 | 386.21 | 30.64 | 28.62 | 29.13 | 29.16 | 2.899 | 3.139 | 10.041 | 11.442 | 28.87 | 27.43 | 13.46 | 12.71 |
| IPA-99 | 413.93 | 451.15 | 37.80 | 41.28 | 39.88 | 39.06 | 3.550 | 3.675 | 10.626 | 12.146 | 33.41 | 30.26 | 12.91 | 12.36 |
| Babyl | 398.04 | 418.78 | 35.10 | 35.38 | 42.27 | 44.06 | 3.465 | 3.905 | 11.221 | 12.174 | 30.88 | 32.08 | 12.62 | 11.36 |
| Bhooth22 | 420.96 | 442.10 | 30.15 | 40.38 | 40.68 | 37.26 | 2.975 | 3.412 | 8.404 | 12.062 | 35.40 | 28.29 | 12.17 | 11.94 |
| Jihad | 426.73 | 456.20 | 32.92 | 35.76 | 38.01 | 40.26 | 3.272 | 3.643 | 10.176 | 11.593 | 32.15 | 31.42 | 12.34 | 11.83 |
| Adina | 439.81 | 468.61 | 35.38 | 36.12 | 39.71 | 40.72 | 3.593 | 3.776 | 11.485 | 11.776 | 31.28 | 32.07 | 12.28 | 11.52 |
| LSD (P≤0.05) | 14.25 | | 2.301 | | 2.684 | | 0.288 | | 0.7 | | NS | | NS | |

Table 8. Effect of the interaction of seeding rate and ethephon on grain yield, components, harvest index, biological yield and protein content.

| Seeding rate | Spikes m ⁻² | | Grains Spikes ⁻¹ | | 1000 grain weight (g) | | Grain yield (t ha ⁻¹) | | Biological yield (t ha ⁻¹) | | Harvest index | | Protein% | |
|--------------|------------------------|--------|-----------------------------|-------|-----------------------|-------|-----------------------------------|-------|--|--------|---------------|-------|----------|-------|
| | E1 | E2 | E1 | E2 | E1 | E2 | E1 | E2 | E1 | E2 | E1 | E2 | E1 | E2 |
| S1 | 394.04 | 448.71 | 39.41 | 33.79 | 37.55 | 38.40 | 3.101 | 3.924 | 9.948 | 11.996 | 31.08 | 32.64 | 12.82 | 12.34 |
| S2 | 420.08 | 467.47 | 41.21 | 36.60 | 36.62 | 35.66 | 3.677 | 3.993 | 11.669 | 12.559 | 31.41 | 31.65 | 12.02 | 11.42 |
| LSD (P≤0.05) | 6.07 | | 1.14 | | NS | | 0.1248 | | 0.296 | | 0.675 | | NS | |



gave highest average by 3.993 and 3.924 t ha⁻¹ respectively. While the interaction of S₁ x E₀ gave lowest average by 3.101 t ha⁻¹. The results of Table 9 showed significant effect for the interaction of wheat varieties, seeding rate and ethephon on grain yield. Alrasheed variety under the interaction of (S₂ x E₁), (S₁ x E₁) and (S₂ x E₀) gave highest average by 4.321, 4.235 and 4.006 t ha⁻¹. While, Wafya under S₁ seeding rate with no foliar application of ethephon (E₀) gave lowest average by 2.727 t ha⁻¹.

Biological yield (t ha⁻¹): The results of Table 5 showed significant differences among wheat varieties, seeding rate and foliar application of ethephon in biological yield. Alrasheed and Mawada varieties gave highest average by 12.435 and 12.192 t ha⁻¹ respectively. Whereas, Bhooth22 gave the lowest average by 10.233 t ha⁻¹. The increase of seeding rate from 140 to 200 kg ha⁻¹ increased biological yield by 10.75%. Foliar application of ethephon significantly increased biological yield by 14.01%. The results of Table 6 indicated that there is significant interaction between wheat varieties and seeding rates. The increase of seeding rate

significantly increased biological yield for all wheat varieties. Alrasheed variety under S₂ seeding rate gave the highest average by 13.669 t ha⁻¹. While, Bhooth22 and Jihad varieties under S₁ seeding rate gave the lowest average by 9.565 and 9.606 t ha⁻¹. The results of table 7 showed that, the interaction of wheat varieties and ethephon have significant effect on biological yield. Foliar application of ethephon significantly increased biological yield for all wheat varieties. Alrasheed and Mawada variety under E₁ foliar application gave highest average 13.116 and 13.063 t ha⁻¹ respectively. While, Bhooth22 variety under E₀ gave the lowest average by 8.404 t ha⁻¹. The results of Table 8 showed significant effect for interaction of seeding rate and foliar application of ethephon on biological yield. Increasing both seeding rate and foliar application of ethephon significantly increased biological yield. The interaction of S₂ x E₁ gave highest average by 12.559 t ha⁻¹, while the interaction of S₁ x E₀ gave lowest average by 9.948 t ha⁻¹. The results of Table 10 showed significant effect for the interaction of wheat varieties, seeding rate and ethephon on grain yield. Alrasheed variety

Table 9. Effect of the interaction of wheat varieties, seeding rate and ethephon on grain yield and components.

| Varieties | Spikes m ⁻² | | | | Grains Spikes ⁻¹ | | | | 1000 grain weight (g) | | | | Grain yield (t ha ⁻¹) | | | |
|--------------|------------------------|--------|--------|--------|-----------------------------|-------|-------|-------|-----------------------|-------|-------|-------|-----------------------------------|-------|-------|-------|
| | S1 | | S2 | | S1 | | S2 | | S1 | | S2 | | S1 | | S2 | |
| | A0 | A1 | A0 | A1 | A0 | A1 | A0 | A1 | A0 | A1 | A0 | A1 | A0 | A1 | A0 | A1 |
| Abugraib3 | 413.80 | 427.78 | 467.47 | 479.46 | 41.52 | 41.44 | 38.60 | 39.12 | 28.29 | 30.48 | 29.62 | 31.42 | 2.796 | 3.592 | 3.337 | 3.475 |
| Alrasheed | 373.13 | 391.38 | 441.71 | 443.75 | 60.20 | 62.04 | 50.76 | 51.72 | 38.02 | 41.61 | 39.12 | 39.78 | 3.745 | 4.235 | 4.006 | 4.321 |
| Barcelona | 438.32 | 453.32 | 495.43 | 519.52 | 39.12 | 40.24 | 32.68 | 34.96 | 28.34 | 33.26 | 29.16 | 29.78 | 3.155 | 3.662 | 3.212 | 3.524 |
| Mawada | 417.16 | 449.94 | 460.74 | 482.10 | 33.52 | 34.08 | 32.56 | 28.92 | 42.49 | 43.54 | 39.50 | 39.14 | 2.983 | 3.575 | 3.828 | 3.831 |
| Jehan | 378.82 | 399.02 | 449.26 | 470.86 | 38.04 | 43.64 | 32.72 | 42.52 | 43.13 | 33.46 | 38.78 | 31.06 | 3.255 | 3.818 | 3.602 | 4.025 |
| Wafyah | 347.66 | 368.66 | 387.89 | 403.76 | 36.04 | 32.20 | 25.24 | 25.04 | 28.13 | 29.73 | 30.13 | 28.60 | 2.263 | 2.727 | 3.535 | 3.551 |
| IPA-99 | 380.49 | 435.25 | 447.38 | 467.05 | 40.48 | 46.20 | 35.12 | 36.36 | 40.87 | 41.76 | 38.89 | 36.35 | 3.305 | 3.426 | 3.795 | 3.923 |
| Babyl | 370.81 | 403.90 | 425.26 | 433.66 | 39.52 | 38.28 | 30.68 | 32.48 | 43.24 | 44.91 | 41.31 | 43.22 | 3.361 | 3.825 | 3.568 | 3.985 |
| Bhooth22 | 394.90 | 418.90 | 447.03 | 465.31 | 31.40 | 42.00 | 24.52 | 38.76 | 40.15 | 38.20 | 41.21 | 36.32 | 2.662 | 3.171 | 3.287 | 3.653 |
| Jihad | 402.94 | 430.54 | 450.52 | 481.86 | 33.20 | 33.00 | 32.64 | 38.52 | 39.82 | 41.98 | 36.20 | 38.55 | 2.872 | 3.309 | 3.671 | 3.977 |
| Adina | 416.46 | 442.30 | 463.16 | 494.92 | 40.42 | 40.20 | 36.21 | 34.19 | 40.53 | 43.42 | 38.89 | 38.02 | 3.489 | 3.598 | 3.697 | 3.954 |
| LSD (P<0.05) | 20.13 | | | | 3.25 | | | | NS | | | | 0.290 | | | |

Table 10. Effect of the interaction of wheat varieties, seeding rate and ethephon on biological yield, harvest index and protein content.

| Varieties | Biological yield (t ha ⁻¹) | | | | Harvest index | | | | Protein% | | | |
|--------------|--|--------|--------|--------|---------------|--------|--------|--------|----------|-------|-------|-------|
| | S1 | | S2 | | S1 | | S2 | | S1 | | S2 | |
| | A0 | A1 | A0 | A1 | A0 | A1 | A0 | A1 | A0 | A1 | A0 | A1 |
| Abugraib3 | 8.958 | 11.057 | 10.887 | 10.944 | 32.008 | 33.076 | 31.291 | 32.381 | 13.50 | 13.42 | 13.49 | 12.75 |
| Alrasheed | 10.432 | 11.970 | 13.075 | 14.261 | 32.921 | 32.958 | 33.763 | 33.623 | 11.94 | 13.34 | 10.63 | 10.16 |
| Barcelona | 9.662 | 12.422 | 11.536 | 12.379 | 28.419 | 31.516 | 29.853 | 30.483 | 13.38 | 12.41 | 12.10 | 11.47 |
| Mawada | 9.712 | 13.161 | 12.932 | 12.964 | 31.333 | 32.919 | 30.280 | 27.923 | 12.41 | 12.28 | 11.57 | 11.29 |
| Jehan | 10.298 | 11.782 | 11.471 | 12.169 | 32.634 | 33.328 | 32.350 | 32.651 | 11.15 | 10.64 | 11.55 | 10.24 |
| Wafya | 9.260 | 11.536 | 10.821 | 11.348 | 28.950 | 29.685 | 29.515 | 26.911 | 13.35 | 12.94 | 13.57 | 12.47 |
| IPA-99 | 9.663 | 12.636 | 11.589 | 11.656 | 32.179 | 33.562 | 32.101 | 31.451 | 13.59 | 12.68 | 12.22 | 12.04 |
| Babyl | 10.734 | 11.86 | 11.708 | 12.488 | 31.542 | 33.216 | 30.688 | 32.868 | 13.31 | 11.36 | 11.92 | 11.35 |
| Bhooth22 | 7.795 | 11.335 | 9.013 | 12.789 | 31.243 | 32.408 | 31.320 | 32.495 | 12.52 | 12.19 | 11.83 | 11.69 |
| Jihad | 9.193 | 10.02 | 11.16 | 13.165 | 31.040 | 32.784 | 32.661 | 33.052 | 13.28 | 12.84 | 11.40 | 10.82 |
| Adina | 11.398 | 11.582 | 11.571 | 11.969 | 30.61 | 31.07 | 31.95 | 33.04 | 12.64 | 11.70 | 11.92 | 11.35 |
| LSD (P<0.05) | 1.021 | | | | NS | | | | NS | | | |



under the interaction of ($S_2 \times E_1$) gave highest average by 14.261 t ha⁻¹. While, Bhooth22 under the interaction of ($S_1 \times E_0$) gave lowest average by 7.795 t ha⁻¹.

Harvest Index: The results of Table 5 showed significant differences between wheat cultivars in harvest index. Alrasheed, Jehan and Jihad gave highest average by 32.80%, 32.20%, and 31.80% respectively. Whereas, Wafya gave the lowest average by 28.12%. The results of Table 5 indicated that, foliar application of ethephon have significant effect on harvest index. Foliar application of ethephon significantly reduced harvest index by 2.50%. The results of Table 6 indicated that there is significant interaction between wheat varieties and seeding rates. IPA-99 and Adina under S_2 seeding rate gave highest average by 33.22% and 33.07% respectively. While, Wafyah gave the lowest average by 24.04%. The results of Table 8 showed significant effect for interaction of seeding rate and foliar application of ethephon on harvest index. Foliar application of ethephon under both seeding rate increased harvest index. The interaction of $S_1 \times E_1$ gave highest average by 32.64%, while the interaction of S_1 and S_2 seeding rate with no ethephon gave lowest average by 31.08% and 31.41% respectively.

Protein content: The results of Table 5 showed significant effect for wheat cultivars, seeding rate and foliar application of ethephon on protein content. Abugraib3, Wafyah, IPA-99 and Barcelona gave highest average by 13.29%, 13.08%, 12.63% and 12.34% respectively. Whereas, Bhooth22 gave the lowest average by 10.233%. The increased of seeding rate from 140 to 200 kg ha⁻¹ reduced protein content by 6.84%. Foliar application of ethephon significantly reduced protein content by 4.35%.

DISCUSSION

Wheat varieties: Wheat growth under desert condition is a big challenge. Were the plants suffering from high temperature, high light intensity, low precipitation, bad structure of soil and insufficient and rapid loss of nutrients (Table 1, 2 and 3). The results of Table 5 showed that wheat varieties differed significantly in all most traits measured. Barcelona produced higher average of spike m⁻² by 491.36. While, Wafyah produced lowest average by 389.66 spike m⁻². Alrasheed variety produced higher average of grains spike⁻¹ and 1000 grain weight by 56.18 and 43.17 g respectively. In other hand Wafyah gave lowest average of grains spike⁻¹ and 1000 grain weight by 29.63 and 29.15 g respectively. Wheat varieties appeared differences in their genetic ability and its interaction with desert condition, and ultimately lead to their differences in grain yield and components. The same results found by (Alsalamy *et al.*, 2021; Pandey *et al.*, 2022; Ullah *et al.*, 2022) which they indicated that wheat varieties defer significantly. For grain yield, Alrasheed variety produced higher grain yield by 4.077 t ha⁻¹ because this variety gave higher grains spike⁻¹ and 1000 grain weight which reflect positively on grain yield

(Table 5). Whereas, Wafyah and Bhooth22 gave lowest average of grain yield by 3.019 and 3.193 t ha⁻¹ respectively. For biological yield, both Alrasheed and Mawada gave highest biological yield by 12.435 and 12.192 t ha⁻¹. While Bhooth22 gave lowest biological yield by 10.233 t ha⁻¹. Biological yield is a total biomass of plant above ground and consists of grain yield and straw yield (Donald and Hamblin, 1976). For harvest index, Alrasheed and Jehan varieties gave higher harvest index by 32.80% and 32.12% respectively. Whereas, Wafyah gave the lowest harvest index by 28.12%. The study of (Wheeler *et al.*, 1996) showed that wheat varieties significantly differed in harvest index. Harvest index refer to the ability of plant to convert photosynthesis product to economic yield (Dai *et al.*, 2016). Both, Alrasheed and Jehan varieties have highest ability to convert photosynthesis product to the grain. In addition both wheat varieties appeared positive ability to grow and gave high biological yield under desert conditions. The results of Table 5 showed significant differences among Wheat varieties in protein content. Abugraib3 and Wafyah recorded highest average by 13.29%. While Jehan gave the lowest average by 10.89%. The study of (Hussain *et al.*, 2006; Kindred *et al.*, 2008; BAŞLAR *et al.*, 2012; Eslami *et al.*, 2014) showed that grain protein is different according to wheat varieties. The results mentioned above indicated that Wheat varieties significantly different in their genetic ability and it is response to desert conditions. Wheat varieties exhibit different grain and biological yield production under harsh conditions were both soil and weather completely different as compared to suitable conditions, soil, water and whether (Eslami *et al.*, 2014; Al-Zubaidi and Mohsen, 2022; Zaibel and Mohsen, 2023). Several studies showed differences among wheat varieties as result to their genetic differences and so their interaction with experimental condition (Gomaa *et al.*, 2018)

Seeding rate:

The results of table 5 showed that, the increase of seeding rate from 140 to 200 kg ha⁻¹ lead to increase spike m⁻² from 407.07 to 458.09 which reflect positively to increased grain yield from 3.330 to 3.716 t ha⁻¹ in spite of reduced grain per spike from 40.31 to 35.20 and 1000 grain weight from 37.97 to 36.14 g. Moreover, the increase of seeding rate from 140 to 200 kg ha⁻¹ (Table 5) increased biological yield from 10.749 to 11.904 t ha⁻¹. While, increased seeding rate reduced protein content. The increased of seeding rate increased plants number per unit area and thus increased competitive between plants on nutrition resource. This results is similar to what found by (Chen *et al.*, 2008; Baloch *et al.*, 2010; Kolb *et al.*, 2012)

Ethephon:

The Results of Table 5 revealed, that foliar application of ethephon from 0 to 2.25 ml l⁻¹ significantly increased spikes m⁻² from 421.38 to 443.78 spikes m⁻², grains per spike from 36.43 to 38.08 which reflected positively to increase grain yield from 3.337 to 3.709 t ha⁻¹. The same trend can be



observed for biological yield, foliar application of ethephon increased biological yield from 10.585 to 12.068 t ha⁻¹. While the results of Table 5 recorded reduction in harvest index from 31.53 to 30.74% and in protein content from 12.42 to 11.88%. Ethephon is growth regulator and foliar application of ethephon at tillering stage reduce or prevented growth of apical meristem for the main stem and then enhance plant to produce tillers. So, foliar application of ethephon lead to increased tillers number and spikes m⁻² which reflect positively to increased grain yield. These results similar to what found by (Ma and Smith, 1992).

Interaction of Wheat varieties and seeding rate: The results of table 6 showed significant effect for the interaction of wheat varieties and seeding rate on all most traits measured. The increased of seeding rate lead to increase spike m⁻², grain yield and biological yield for all wheat varieties. In other hand, increased seeding rate reduced grains spike, harvest index and protein content for all wheat varieties. The increased of seeding rate from 140 to 200 kg ha⁻¹ increased spikes m⁻² which reflect positively to increased grain yield for all wheat varieties, in spite of the significant reduction in grains per spike (Table 6). Alrasheed under seeding rate of 200 kg ha⁻¹ gave highest grain and biological yield by 4.164 and 13.669 t ha⁻¹ respectively. The results of Table 6 showed that in spite of IPA-99 and Adina produced low grain and biological yield under 200 kg ha⁻¹ of seeding rate as compared to Alrasheed, but these two varieties have high ability to translocate photosynthesis product and storage food to grain. This is clearly appeared by high average of harvest index by 33.22% and 33.07% respectively. Maybe this is because of the single effect of the two studied factors.

Interaction of Wheat varieties and Ethephon: The results of table 7 showed significant effect for the interaction of wheat varieties and foliar application of ethephon on spike m⁻², grains spike⁻¹, 1000 grain weight, grain yield and biological yield. Foliar application of ethephon increased spike m⁻² for all wheat varieties. Ethephon reduce or prevented growth of apical meristem for the main stem and enhance plant to produce tillers which reflect positively to increase spike m⁻². The results of table 7 showed that grain component (grains spike⁻¹ and 1000 grain weight) of wheat varieties have different response for ethephon foliar application. In one case ethephon foliar application lead to increased grains spike⁻¹ like what happened with Jehan, Ibaa99, Bhooth22 and Jihad. While, in other case foliar application of ethephon have no significant effect on grains spike⁻¹ like what happened with Alrasheed variety. Foliar application of ethephon have no clear effect for wheat variety especially on 1000 grain weight. Alrasheed and Jihad gave highest average with ethephon by 40.70 and 40.26 g respectively (Table 7). The results of table 7 revealed that foliar application of ethephon increased both grain and biological yield for all wheat varieties, as a results of increased spikes m⁻² which is one of more important grain yield components. Alrasheed under ethephon foliar

applications gave highest grain yield by 4.278 t ha⁻¹ because this variety produced highest grains spike⁻¹ and 1000 grain weight (Table 7). Same trained can be observed for biological yield as well as grain yield for both Alrasheed and Mauada which they gave highest biological yield by 13.116 and 13.063 t ha⁻¹ respectively.

Interaction of seeding rate and Ethephon: The results of Table 8 indicated that the interaction of seeding rate and foliar application of ethephon have significant effect on spikes m⁻², grains spike⁻¹, grain yield, biological yield and harvest index. High seeding rate of S₂ with ethephon E₁ gave highest spikes m⁻² by 467.47, while the interaction of S₁ x E₂ gave highest grains spike⁻¹. In other hand both interactions of S₂ x E₁ and S₁ x E₀ gave highest grain yield by 3.993 and 3.924 t ha⁻¹ respectively. The results showed that S₂x E₁ interaction gave highest biological yield by 12.559 t ha⁻¹. Moreover the interaction of S₁x E₁ gave highest harvest index by 32.64 this indicted that, the addition of ethephon improve translocation of photosynthesis product to grain. Maybe this is because of the single effect of the each single factor.

Interaction of wheat varieties, seeding rate and Ethephon: The results of Table 9 and 10 showed that, the interaction of wheat varieties, seeding rate and ethephon have significant effect on spikes cm⁻², grains spike⁻¹, grain yield and biological yield. Barcelona under the interaction of S₂ x E₁ gave highest average by 519.52 spike cm⁻². Alrasheed variety under the interaction of S₁ x E₁ and S₁ x E₀ gave highest grains spike⁻¹ by 62.04 and 60.20 respectively. Alrasheed under high seeding rate with spraying with ethephon (S₂ x E₁) and with low seeding rate and ethephon (S₁ x E₁) produced highest grain yield by 4.321 and 4.235 t ha⁻¹ respectively. This indicated that spraying of ethephon compensate the use of high seeding rate. In fact, this case (spraying of ethephon compensate the increase of seeding rate) is exist with Abugraib3, Alrasheed, Barcelona, Mauada, Jehan and Babyl varieties (Table 9). This is considering a good indicator to reduced seeding rate in such conditions (desert condition) especially when the seeds cost a lot and high expensive or where there is loss of seedling. In addition, Alrasheed under the interaction of S₂ x E₁ gave highest biological yield by 14.261 t ha⁻¹ (Table 12). For all wheat varieties, the increased of seeding rate and foliar application of ethephon have positive effect on spike m⁻², grain yield and biological yield. While, there is no clear effect for the interaction of seeding rate and ethephon application for all most wheat varieties in grains spike⁻¹. In other hand, Wafya under S₁ x E₀ gave lowest average of spike m⁻² by 347.66 spike m⁻². For grains spikes⁻¹ the results showed that bohooth22 under the interaction of S₂ x E₀ and Wafyah under the interaction of S₂ x E₀ and S₂ x E₁ gave lowest average by 24.52, 25.04 and 25.24 grains spikes⁻¹ respectively. For grain yield Wafyah under S₁x E₀ gave lowest average by 2.263 t ha⁻¹. For biological yield Bohooth22 under the interaction of S₁x E₀ gave lowest average by 7.795 t ha⁻¹.



Conclusion: We conclude that, wheat varieties appeared different response to grow under desert conditions according to their genetic and acclimation ability to harsh environments at desert condition. Alrasheed variety gave highest grain spike⁻¹ and 1000 grains weight which reflect positively to produce highest grain yield by 4.077 t ha⁻¹. Abugraib3, Wafyah, IPA-99 and Barcelona gave highest average of protein content by 13.29%, 13.08%, 12.63% and 12.34% respectively. Increasing seedling rate at desert agriculture is important for wheat, to increase spike m⁻² which is one of the most important grain yield component. Moreover, foliar application of growth regulator ethephon lead to enhance grain yield and some components for all wheat varieties at desert agriculture. In addition foliar application of ethephon compensate the increase of seeding rate from 140 to 200 kg ha⁻¹ for grain yield trait of some wheat varieties.

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